

Image Schemata in Animated Metaphors for Insight Problem Solving

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ABSTRACT

While most of the work on metaphors has focused on conceptual ones, less attention has been paid to the visual metaphors for insight problems. This paper investigates the role of dynamism and realism in visual metaphors for cueing the insight problem solving process. To match the visual-kinesthetic feature of the eight-coin insight problem, the developed metaphors represented the insight cues, both kinetically and kinesthetically. An experimental study showed the superiority of metaphors as realistic and continuous animations over schematic and discrete animations.

Keywords

Visual insight problem, visual metaphors, animation, realism, image schemata.

ACM Classification Keywords

H5.2. Information interfaces and presentation (e.g., HCI):
User Interfaces: Theory and methods.

General Terms

Human Factors

INTRODUCTION

By capturing the similarities between two domains, metaphors support the transfer of meaning from the source to the target. Different types of metaphors and predominantly conceptual ones have been investigated for their role in perception, learning, problem solving and creativity, whereas less work has focused on the role of nonverbal metaphors in insight problem solving. The existing work in insight problems offers conflicting findings on the effectiveness of different types of visual metaphors agreeing however that levels of dynamism and realism are important factors to be considered. Visual metaphors appear to be particularly successful when augmented with kinetic or kinesthetic information but no study has compared their effectiveness when such information is embedded in the metaphor's content. The paper reports the findings on the eight-coin insight problem using discrete and dynamic animations embedding image schemata to capture kinetic and kinesthetic information relevant for the insight.

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METHODOLOGY

The experimental study explores three features of visual cues which may impact their success in supporting problem solving. Previous work on eight-coin problem suggests that the visual cues offering information about the initial and final state of the problem do not lead to higher success rate than those capturing only the final or solution state [10]. However, if well understood, the visual cues capturing more than the final state could be beneficial because they may allow better analogical transfer. To further explore this, we developed visual metaphors not as static images as in [10] but as *animations*, both continuous, i.e. computer-based simulations, and discrete, i.e. sequence of static pictures.

While the apprehension principle proposed by Tversky [11] argues that animations should be less realistic, the importance of *realistic* animations in learning has been emphasized by Höffler and Leutner's meta-analysis [2]. Michas and Berry [6] also argued that static pictures can be more effective if they represent a set of key moments in the process or have a high level of realism. To further explore these outcomes, we considered two levels of realism: schematic for which we used only primary depth cues, and realistic which benefited from both primary and secondary cues, i.e., light, shadow, atmospheric perspective and gradients [9].

Previous findings have also shown the impact of animations on the acquisition of procedural-motor knowledge [2]. Interestingly, the expected superiority of animations in supporting problem solving has not been identified [5], and the link between the observational learning of motor skills and cognitive skills has not been investigated. Although the tied interdependence between *image schemata* and motor skills has been already advocated by Lakoff and Johnson [3], their role in insight problem solving has not been yet explored. A notable exception is Catrambone et al. [1] who investigated the role of perceptual kinesthetic information in analogical reasoning. Our study is the first to investigate the role of animations in insight problem solving through visual representations of image schemata capturing both kinetic (i.e. force-based) and kinesthetic (gesture-based) information.

The reason for focusing on the eight-coin insight problem is twofold: the problem is delivered in a kinesthetic format, and each of the two insights involving object manipulation can be directly linked to available image schemata. To detail, the eight coins in the initial configuration are provided on the table in front of participants who are required to solve the problem by placing the coins in the right position. Solving the problem involves physical manipulations of the coins and the insights of grouping and stacking. We argue that these insights activate two specific image schemata: splitting schemata for the grouping insight, and verticality (up and down) schemata for the stacking insight. The sample consisted of 130 participants, 26 for each of the 4 experimental and control groups. The overall sample consisted of 55% males and 45% females and over 75 % were between 21 and 30 years of age. Participants were randomly assigned to conditions and after two minutes of working on the problem, they were stopped and advised to watch the first visual metaphor and then to resume the work for another two minutes. The procedure was repeated for the second metaphor and after a total of 6 minutes of solution attempts, the test ended and the result was marked as successful or unsuccessful.

FINDINGS

The most important outcome of this study is that each of the four conditions has led to success rates above 50%, with the highest value of 75% for the continuous realistic animation (Table 1). This is impressive given that visual insight problems are notoriously difficult to solve with a success rate for the control group seldom higher than 10%, i.e. 13% for radiation problem [8] or 9.4% for nine dots [4]. For the eight-coin problem, when stacking and grouping cues were verbally provided the success rate was 42.8% (Exp.1 in [7]), whereas the static visual cues enabled 50% success rate [10]. Exact binomial sign tests showed that the four types of metaphors enabled significantly higher success rate than the control group (7%) ($p < 0.01$), and that metaphors captured as continuous animations using secondary depth cues have led to significantly higher success rate (73%) than the metaphors depicted as discrete animations through primary depth cues (50%) ($p = 0.01$). The outcome is important given the limited engagement with the metaphors. For example, success rate over 80% was obtained in radiation problem [8] but participants had to recall each analogy through written descriptions, whereas in our study they were actively exposed for only 38 seconds to each of the two metaphors without being asked to recall them later.

The findings also emphasize the importance of image schemata and animations on motor knowledge for insight problem solving. An important aspect is the nature of the eight-coin problem both in terms of content, i.e., visual, spatial, three dimensional; and its form of delivery, i.e., visual-kinesthetic perception and object manipulation. It is this nature of the problem and the process of solving it which involves forces and gestures that makes image schemata a suitable candidate to represent the insight cues.

Condition	Force	Gestures	Total
Control group	NA	NA	2 (7)
Discrete animation primary 3D	5	8	13 (50)
Discrete animation secondary 3D	5	10	15 (57.7)
Continuous animation primary 3D	8	7	15 (57.7)
Continuous animation secondary 3D	8	11	19 (73)

Note: Numbers in parentheses are percentages, $n = 26$ in each condition

Table 1: Number of participants who solved the problem.

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